



Critical Care Therapy and Respiratory Care Section

Category:	Clinical
Section:	Aerosol Therapy
Title:	Delivery of Medicinal Aerosols to the Upper and Lower Airways
Policy #:	04
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1.0 DESCRIPTION

1.1 Definition: This procedure describes proper delivery of therapeutic aerosols to the airways including the nose, pharynx, and larynx in adult and pediatric patients. Therapeutic aerosols are indicated for airway inflammation, anesthesia, rhinitis, and administration of medication for systemic effects. Selection of an appropriate aerosol delivery device must be based on a thorough evaluation of the patient's ability to perform device-specific maneuvers. Special considerations for aerosol delivery in pediatric patients are outlined.

1.2 Indications

- 1.2.1 The need to deliver (as an aerosol to the upper or lower airways) a medication from one of the following drug classifications:
 - 1.2.1.1 *Beta adrenergic agents*
 - 1.2.1.2 *Anticholinergic agents (antimuscarinics)*
 - 1.2.1.3 *Anti-inflammatory agents (i.e., corticosteroids)*
 - 1.2.1.4 *Mediator-modifying compounds (i.e., cromolyn sodium)*
 - 1.2.1.5 *Mucolytics*
 - 1.2.1.6 *Wetting agents (i.e., 0.9% NaCl)*
- 1.2.2 Upper airway inflammation (i.e., to relieve inflammation due to laryngotracheobronchitis)
- 1.2.3 Anesthesia (i.e., to control pain and gagging during endoscopic procedures)
- 1.2.4 Rhinitis (i.e., to relieve inflammation and vascular congestion)
- 1.2.5 Systemic disease (i.e., to deliver peptides such as insulin, antibiotics)

1.3 Contraindications

- 1.3.1 Contraindications related to the substances being delivered may exist. **NOTE:** Consult the package insert for product-specific contraindications.
- 1.3.2 Known hypersensitivity to the substance being delivered.

1.4 Precautions / Complications

- 1.4.1 Administration of medication for upper airway inflammation may result in:
 - 1.4.1.1 Bronchospasm
 - 1.4.1.2 Rebound of symptoms
 - 1.4.1.3 Systemic side effects
- 1.4.2 Administration of medications for anesthesia may result in:
 - 1.4.2.1 Inhibition of gag reflex
 - 1.4.2.2 Choking
 - 1.4.2.3 Dehydration of epithelium
 - 1.4.2.4 Allergic reactions
 - 1.4.2.5 Excessive systemic effect
 - 1.4.2.6 Bronchospasm
 - 1.4.2.7 Nosocomial infection from contaminated delivery device or medication
- 1.4.3 Administration of medications for rhinitis may result in:
 - 1.4.3.1 Nasal rebound after extended use of alpha adrenergic decongestants
 - 1.4.3.2 Delayed effect (i.e., effects of corticosteroids are not immediate)
 - 1.4.3.3 Sensation of irritation and burning in the nose
 - 1.4.3.4 Sneezing attacks (immediately following administration)
 - 1.4.3.5 Mucosal ulceration and bleeding
 - 1.4.3.6 Postnasal drip
- 1.4.4 Administration of medication for systemic disease may result in:
 - 1.4.4.1 Nasal irritation of toxic effects

NOTE: See the package insert for specific potential complications.

- 1.4.5 Administration of albuterol via continuous nebulizer may result in:
 - 1.4.5.1 Skeletal muscle tremor
 - 1.4.5.2 Increased blood pressure, tachycardia, and dysrhythmias
 - 1.4.5.3 Decreases potassium, magnesium, or phosphate, increased or decreased glucose

1.5 Limitations of Procedure

- 1.5.1 Upper airway inflammation: Patient cooperation is not essential but may be desirable for effective administration in some applications.
- 1.5.2 Anesthesia: Local application of anesthetic agents may require direct visualization.
- 1.5.3 Rhinitis:
 - 1.5.3.1 In the presence of excessive nasal mucus secretions or edema of the nasal mucosa, the drug may fail to reach the site of intended action. Deposition may be compromised by the presence of nasal polyps or a deviated septum.
 - 1.5.3.2 Response may not be readily observable for drugs such as cromolyn sodium and corticosteroids.
- 1.5.4 Systemic disease:
 - 1.5.4.1 In the presence of excessive nasal mucus secretions or edema of the nasal mucosa, the drug may fail to reach the site of intended action. Deposition may be compromised by the presence of nasal polyps or a deviated septum.
 - 1.5.4.2 Response may not be immediately apparent.
- 1.5.5 Only a small percentage of aerosol output (less than ten percent) deposits in the airway.
- 1.5.6 Efficacy of the device is technique dependent (i.e., coordination, breathing pattern, inspiratory hold).
- 1.5.7 Efficacy of the device is design dependent (i.e., output and particle size).
- 1.5.8 Reduced deposition of aerosol to the lower airways is associated with the following and may require consideration of increased dose:
 - 1.5.8.1 Mechanical ventilation
 - 1.5.8.2 Artificial airways
 - 1.5.8.3 Small airway caliber (i.e., infants and children)
 - 1.5.8.4 Severity of airways obstruction
 - 1.5.8.5 Patient compliance

1.6 Device Selection

- 1.6.1 For nasopharyngeal deposition, the device selected should produce particles with a mass median aerodynamic diameter in the range of 5-20 microns. Devices for upper airway delivery include:
 - 1.6.1.1 **Metered Dose Inhaler (MDI):** A canister device used to administer a medication in vapor form. Each actuation of the inhaler delivers a pre-determined bolus of medication to the patient's upper airway. The dosage delivered is dependent on the drug being given and the ability of the patient to perform the treatment effectively. Each canister provides approximately 200 actuations.
 - 1.6.1.2 **Metered Spray Pump (MSP):** A pump device designed to deliver a medication in spray form. Each actuation of spray delivers a pre-determined bolus of medication to the patient's lungs. The dosage delivered is dependent on the drug being given and the ability of the patient to perform the treatment effectively.
 - 1.6.1.3 **Hand-bulb Atomizer (HBA):** A device made up of a reservoir containing the medication to be aerosolized, a capillary tube, and a jet. The capillary tube lateral pressure draws medication up the capillary tube and the gas stream emerging from the jet breaks the medication into particles. HBAs are most commonly used to deliver anesthetic medications.
 - 1.6.1.4 **Small-volume Nebulizer (SVN):** A device that allows for the nebulization of medication without positive pressure. The nebulizer is powered by either oxygen or compressed air. Younger patients (usually less than three years of age) and other patients unable to negotiate the use with a mouthpiece will require the use of an aerosol face mask for effective utilization of this device.
 - 1.6.1.5 **Large Volume Nebulizer (LVN):** A device that is identical in function to the SVN but is able to utilize a larger amount of medication resulting in a longer delivery time to the patient; used in conjunction with an aerosol face mask.
 - 1.6.1.6 **Ultrasonic Nebulizer (USN):** A device that uses a piezoelectric transducer to produce ultrasonic waves that pass through the medication to be aerosolized; usually used in conjunction with an aerosol face mask.
- 1.6.2 For lower airway deposition, the device selected should produce particles with a mass median aerodynamic diameter in the range of 2-5 microns. Devices for lower airway delivery include:
 - 1.6.2.1 **Metered Dose Inhaler (MDI):** See above.

An **accessory device** (i.e., spacer) may be added to an MDI to aid in optimum delivery of the medication. A **spacer with face mask device** should be used for patients less than three years of age and others unable to use a mouthpiece effectively.

- 1.6.2.2 **Dry Powder Inhaler (DPI):** A device used to dispense a dry powdered drug into the airway. The DPI's effectiveness is dependent on an adequate inspiratory flow (at least 50 LPM) to carry the dry particles to the lower airway. Therefore, this device is inappropriate for use in patients less than six years of age.
- 1.6.2.3 **Small Volume Nebulizer (SVN):** See above.
- 1.6.2.4 **Large Volume Nebulizer (LVN):** See above.
- 1.6.2.5 **Ultrasonic Nebulizer (USN):** See above.

1.7 Limitations of Specific Devices

1.7.1 Metered Dose Inhaler

- 1.7.1.1 Environmental concerns over the emission of chlorofluorocarbons
- 1.7.1.2 Adequate/Inadequate technique:
 - 1.7.1.2.1 The adult patient should have a vital capacity of 900 ml or greater (children have lower vital capacities based upon their lower weights).
 - 1.7.1.2.2 The patient should be able to hold the inspired vital capacity for a minimum of five seconds.
 - 1.7.1.2.3 The patient should have a respiratory rate less than 25 breaths per minute.
 - 1.7.1.2.4 The patient should be oriented and able to respond appropriately.
 - 1.7.1.2.5 The patient must demonstrate full motion of the arm and hand used to actuate the MDI canister or it is necessary to have someone available who may perform these motions effectively for the patient.
 - 1.7.1.2.6 The patient should demonstrate adequate actuation of the MDI at early inspiration. If unable to achieve this, the patient should be instructed in the use of a spacer device.
- 1.7.1.3 Inadequate instruction
- 1.7.1.4 The MDI canister is under pressure. Do not puncture. Do not use or store near open heat or flame. Exposure to temperatures above 120 degrees F. may cause the canister to rupture.
- 1.7.1.5 The MDI canister should be stored at temperatures between 50 and 86 degrees F. **NOTE:** Failure to use the

- MDI within the proper temperature range may result in improper dosing.
 - 1.7.1.6 The MDI canister must be shaken well before each actuation.
- 1.7.2 MDI Accessory Device:
 - 1.7.2.1 Adds to the cost of using just the MDI alone
 - 1.7.2.2 More bulky than MDI alone
- 1.7.3 Dry Powder Inhaler:
 - 1.7.3.1 Patients must load each dose for dry powder medications
 - 1.7.3.2 Reduced inspiratory flow (less than 50 LPM) can lead to reduced deposition. Patients must be monitored for the adequacy of the inspiratory effort
 - 1.7.3.3 May cause irritation to the airway
 - 1.7.3.4 Humidity may cause clumping of particles
- 1.7.4 Small Volume Nebulizer:
 - 1.7.4.1 Time and labor intensive
 - 1.7.4.2 Less portable
 - 1.7.4.3 Requires compressed-gas source or electricity
 - 1.7.4.4 Vulnerable to contamination
 - 1.7.4.5 Lack of convenience may affect patient compliance
 - 1.7.4.6 Patient must breathe large, slowly inspired tidal volumes and incorporate a momentary inspiratory hold for optimum deposition. Small tidal volumes and high inspiratory flows as may occur with crying, may reduce deposition.
 - 1.7.4.7 Nasal breathing reduces particle deposition
- 1.7.5 Large Volume Nebulizer:
 - 1.7.5.1 Limited to acute and critical care settings
 - 1.7.5.2 Requires close monitoring
 - 1.7.5.3 Time and cost intensive
 - 1.7.5.4 Vulnerable to contamination
 - 1.7.5.5 Re-concentration of solution may occur over long period of time due to evaporation by dry gas
 - 1.7.5.6 Nasal breathing reduces particle deposition
- 1.7.6 Ultrasonic Nebulizer:
 - 1.7.6.1 Cost of device
 - 1.7.6.2 Mechanical reliability
 - 1.7.6.3 Requires electrical power source
 - 1.7.6.4 Vulnerable to contamination

2.0 AEROSOLIZED MEDICATIONS

2.1 Albuterol (Proventil, Ventolin)

2.1.1 Method of Action:

- 2.1.1.1 Sympathomimetic
- 2.1.1.2 Selective beta 2 stimulant
- 2.1.1.3 Has no alpha effect; bronchodilator.

2.1.2 Dosage, Frequency and Duration:

- 2.1.2.1 MDI: Two to four puffs
- 2.1.2.2 SVN: 0.25 to 0.5 ml diluted with 0.9% NaCl to a total volume of 3 ml.
- 2.1.2.3 LVN: Same concentration as SVN with increased total volume.

Duration of four to six hours.

Alternatively, nebulized bronchodilators may be given continuously if indicated by the severity of symptoms to achieve a dosage of 0.05 to 0.40 mg/kg/hr. Refer to the "Heart Nebulizers" "Guidelines for Preparing Hourly Doses" at the end of this document for specific dosing information.

2.1.3 Indications: Relief of reversible bronchospasm

2.1.4 Hazards: Increased heart rate and blood pressure least likely with this bronchodilator, but still possible.

2.2 Metaproterenol (Alupent, Metaprel):

2.2.1 Method of Action:

- 2.2.1.1 Sympathomimetic
- 2.2.1.2 Primary beta 2 stimulant
- 2.2.1.3 Bronchodilator

2.2.2 Dosage, Frequency and Duration:

- 2.2.2.1 MDI: Two puffs
- 2.2.2.2 SVN: 0.2 to 0.3 ml diluted with 0.9% NaCl to a total volume of 3 ml
- 2.2.2.3 LVN: Same concentration as SVN with increases total volume.

Duration of four hours.

2.2.3 Indications: Relief of reversible bronchospasm

2.2.4 Hazards: Monitor for increased heart rate and increased blood pressure

2.3 Isoetharine (Bronkosol, Dilabron):

2.3.1 Method of Action:

- 2.3.1.1 Sympathomimetic beta 1
- 2.3.1.2 Beta 2 stimulant
- 2.3.1.3 Bronchodilator

2.3.2 Dosage, Frequency and Duration:

- 2.3.2.1 SVN: 0.25 to 0.5 ml diluted with 0.9% NaCl to a total volume of 3 ml
 - 2.3.2.2 LVN: Same concentration as SVN with increased total volume
- Duration of one and a half to three hours.

2.3.3 Indications: Relief of reversible bronchospasm

2.3.4 Hazards: Monitor for increased heart rate, increased blood pressure and tremors.

2.4 Racemic Epinephrine (Vaponefrin, Micronefrin, S2)

2.4.1 Method of Action:

- 2.4.1.1 Sympathomimetic
- 2.4.1.2 Alpha and beta stimulant
- 2.4.1.3 Vasoconstriction
- 2.4.1.4 Increases heart rate and force
- 2.4.1.5 Bronchodilator

2.4.2 Dosage, Frequency and Duration:

- 2.4.2.1 SVN: 0.25 to 0.5 ml diluted with 0.9% NaCl to a total volume of 3 ml
 - 2.4.2.2 LVN: Same concentration as SVN with increases total volume
- Duration less than one hour

2.4.3 Indications: Relief of stridor, especially helpful for stridor post-extubation

2.4.4 Hazards:

- 2.4.4.1 Tachycardia
- 2.4.4.2 Palpitations
- 2.4.4.3 Increased blood pressure
- 2.4.4.4 Headache

- 2.4.4.5 Nervousness
- 2.4.4.6 Tremors

2.5 Terbutaline Sulfate (Bricanyl, Brethine)

- 2.5.1 Method of Action:
 - 2.5.1.1 Sympathomimetic
 - 2.5.1.2 Preferentially beta 2 stimulant
 - 2.5.1.3 Bronchodilator with minimal cardiac side effects
- 2.5.2 Dosage, Frequency and Duration:
 - 2.5.2.1 MDI: Two puffs
 - 2.5.2.2 SVN: 0.5 ml diluted with 0.9% NaCl to a total volume of 3 ml
 - 2.5.2.3 LVN: Same concentration as SVN with increased total volumeDuration 4 to 6 hours
- 2.5.3 Indications: Relief of reversible bronchospasm
- 2.5.4 Hazards: Increased heart rate; increased blood pressure less likely, but still possible

2.6 Ipratropium Bromide (Atrovent):

- 2.6.1 Method of Action:
 - 2.6.1.1 Anticholinergic bronchodilator; prevents increases in cyclic GMP; bronchodilation is primarily a local, rather than systemic effect
- 2.6.2 Dosage, Frequency and Duration:
 - 2.6.2.1 MDI: 2 puffs
 - 2.6.2.2 SVN: 2.5 ml
 - 2.6.2.3 LVN: Same concentration as SVN with increased total volumeQID, duration up to 6 hours
- 2.6.3 Indications: Bronchodilator for maintenance treatment of bronchospasm in COPD
- 2.6.4 Hazards:
 - 2.6.4.1 Increased heart rate
 - 2.6.4.2 Dizziness, nausea
 - 2.6.4.3 Vomiting
 - 2.6.4.4 Tremor
 - 2.6.4.5 Blurred vision

2.6.4.6 Dry mouth

2.7 Atropine:

2.7.1 Method of Action:

2.7.1.1 Parasympatholytic; blocks the activation of cyclic GMP to prevent bronchospasm

2.7.2 Dosage, Frequency and Duration

2.7.2.1 SVN: 1 mg (0.1 ml of 1% solution diluted with 2-3 ml of 0.9% NaCl or 0/5 mg/kg)

2.7.2.2 LVN: Same concentration as SVN with increased total volume

Usually given QID or Q4 hours

2.7.3 Indications: To prevent bronchospasm. Improves airway resistance and forced expiratory flow in asthmatics.

2.7.4 Hazards:

2.7.4.1 Thickening of bronchial secretions

2.7.4.2 Mucus plugging

2.7.4.3 Increase in heart rate

2.7.4.4 Dry mouth

2.8 Acetylcysteine (Mucomyst, Mucosol):

2.8.1 Method of Action: Breaks mucus chains by replacing the disulfide bond in mucus with its own sulfhydryl groups. Lowers viscosity of mucus.

2.8.2 Dosage, Frequency and Duration:

2.8.2.1 SVN: 2 to 3 ml of 10% or 20% solution diluted with equal amounts of sterile 0.9% NaCl

2.8.2.2 LVN: Same concentration as SVN with increases total volume

Administered TID or QID.

May be directly instilled in tracheostomy or endotracheal tube *after* aerosolization of an effective bronchodilator.

2.8.3 Indications: For patients with thick, viscous secretions

2.8.4 Hazards: May precipitate bronchospasm; should only be used in conjunction with a bronchodilator; incompatible in mixture with some antibiotics.

2.9 Pentamidine Isethionate (Pentam 300):

- 2.9.1 Method of Action: Agent known to have activity against *Pneumocystis carinii*. It is thought to inhibit synthesis of DNA, RNA, phospholipids and proteins.
- 2.9.2 Dosage, Frequency and Duration: 300 mg is nebulized once a month prophylactically to prevent *P. carinii* pneumonia.
- 2.9.3 Indications: Inhaled prophylaxis regimen has been used for patients with CD4 counts of 200 or below who have a contraindication to sulfa prophylaxis.
- 2.9.4 Hazards:
 - 2.9.4.1 Wheezing in patients with irritable airways
 - 2.9.4.2 Hypoglycemia, pancreatic islet cell necrosis
 - 2.9.4.3 Hypotension and ventricular dysrhythmias (if intravascularly or intramuscularly administered).

Intravenous pentamidine is given as treatment for *P. carinii* pneumonia.

2.10 Triamcinolone Acetonide or Beclomethasone Dipropionate (Azmacort; Vanceril or Beclovent):

- 2.10.1 Method of Action: Local anti-inflammatory synthetic corticosteroid which inhibits mast cell release.
- 2.10.2 Dosage, Frequency and Duration: MDI: 2 to 3 puffs, BID
- 2.10.3 Indications: Inhaled drug for patients who require chronic treatment with corticosteroids for the control of symptoms of bronchial asthma.
- 2.10.4 Hazards: It is not considered a bronchodilator and is not indicated as primary treatment of acute episodes of asthma. Adrenal insufficiency can occur in patients previously given systemic corticosteroids for control of bronchial asthma who are switched to inhaled corticosteroids since it does not provide systemic level of steroid. Localized infections in the mouth and pharynx with *Candida albicans* and *Aspergillus niger* can occur. **NOTE:** The mouth should be rinsed with water after each treatment.

2.11 Hypertonic Saline:

- 2.11.1 Method of Action: Assists in liquefaction of viscid sputum. Adds humidity to respiratory tract.

2.11.2 Dosage, Frequency and Duration: 3% NaCl solution, PRN for up to 45 minutes via SVN or USN.

2.11.3 Indications: When viscid sputum interferes with effective expectoration.

2.11.4 Hazards:

- 2.11.4.1 Bronchospasm
- 2.11.4.2 Local irritation and coughing
- 2.11.4.3 Overhydration
- 2.11.4.4 Congestive heart failure in children
- 2.11.4.5 Contamination of solution or delivery device

2.12 Lidocaine HCL (Xylocaine):

2.12.1 Method of Action: A local anesthetic of the amide type. Blocks depolarization by interfering with sodium-potassium exchange across the nerve cell membrane, preventing generation and conduction of the nerve impulse.

2.12.2 Dosage, Frequency and Duration: 4.5 mg/kg for local anesthesia, PRN via HBA or SVN.
Variable duration of minutes.

2.12.3 Indications: For topical anesthesia

2.12.4 Hazards:

- 2.12.4.1 Dermatologic reactions
- 2.12.4.2 Edema
- 2.12.4.3 Status asthmaticus
- 2.12.4.4 Anxiety
- 2.12.4.5 Nervousness
- 2.12.4.6 Seizures
- 2.12.4.7 Tremors
- 2.12.4.8 Twitches
- 2.12.4.9 Arrhythmias
- 2.12.4.10 Blurred vision
- 2.12.4.11 Tinnitus
- 2.12.4.12 Nausea
- 2.12.4.13 Vomiting
- 2.12.4.14 Cardiac arrest

2.13 Serevent (salmeterol xinafoate):

- 2.13.1 Method of Action: A long acting beta 2 adrenergic agonist. It is thought to convert ATP to cyclic AMP. Increased cyclic AMP level causes relaxation of bronchial smooth muscle and inhibits release of mediators of immediate hypersensitivity from cells, especially from mast cells.
- 2.13.2 Dosage, Frequency and Duration: MDI, 2 puffs Q12 hours. Duration is up to 12 hours.
- 2.13.3 Indications: Long-term maintenance treatment of asthma and prevention of bronchospasm in patients with reversible obstructive airway disease including nocturnal asthma and exercise-induced bronchospasm.
- 2.13.4 Hazards: Do not use to treat acute symptoms. Not a substitute for inhaled or oral corticosteroids. Paradoxical bronchospasm. Laryngeal spasm, stridor, choking. **CAUTION:** Do not administer to patients under the age of 12 years.

2.14 Intal (Cromolyn sodium):

- 2.14.1 Method of Action: Anti-inflammatory agent that inhibits sensitized mast cell degranulation by blocking calcium ions from entering the mast cell, thereby preventing mediator release.
- 2.14.2 Dosage, Frequency and Duration:
 - 2.14.2.1 MDI: 2 puffs QID
 - 2.14.2.2 SVN: 2 ml QIDMost effective the first 60 minutes after administration.
- 2.14.3 Indications: Prophylactic management of bronchial asthma.
- 2.14.4 Hazards:
 - 2.14.4.1 Cough
 - 2.14.4.2 Bronchospasm
 - 2.14.4.3 Throat irritation and dryness
 - 2.14.4.4 Bad taste
 - 2.14.4.5 Wheeze
 - 2.14.4.6 Nasal Congestion
 - 2.14.4.7 Dizziness
 - 2.14.4.8 Joint swelling and pain
 - 2.14.4.9 Headache
 - 2.14.4.10 Rash
 - 2.14.4.11 Swollen parotid glands

2.14.4.12 Nausea

Must be administered on a regular basis to achieve full benefit. Do not administer to patients under the age of 5 years.

2.15 Adverse Reactions and **Interventions**

- 2.15.1 Inappropriate gas source was chosen (the patient exhibits signs of limitation of hypoxic drive; i.e., patient has diminished drive to breathe with a decrease of rate and/or a decrease in the depth of respirations).

Return patient to pre-treatment FiO₂ and monitor closely. Inform physician.

- 2.15.2 The patient exhibits tachycardia to 15 beats above baseline heart rate or develops an increase in dysrhythmias.

Stop treatment. Notify physician. Monitor closely.

- 2.15.3 The patient develops bronchospasm while receiving medications known to precipitate bronchospasm (i.e., pentamidine, acetylcysteine, corticosteroids) or as a reaction to propellants, preservatives, other additives, or dry powder.

Stop the treatment and notify the physician. Obtain an order for a bronchodilator and administer.

- 2.15.4 Patient receiving a bronchodilator reports significant tremors and/or light-headedness.

Stop the treatment, and notify the physician. Obtain an order for a SVN.

3.0 EQUIPMENT

3.1 MDI

- 3.1.1 MDI canister with mouthpiece/actuator
- 3.1.2 Spacer device with or without face mask (Aerochamber, Aerovent) if needed
- 3.1.3 Universal precautions attire
- 3.1.4 Stethoscope

3.2 SVN/LVN

- 3.2.1 SVN/LVN with tubing

- 3.2.2 Aerosol mask for children less than three years of age and for those unable to use a mouthpiece correctly
- 3.2.3 Tracheostomy collar or T-piece for patients with artificial airways
- 3.2.4 Medications as ordered by physician
- 3.2.5 Oxygen or compressed air source as ordered; alternatively, an oxygen blender may be used to titrate the FiO_2 desired. This may be especially useful during continuous nebulizer therapy.
- 3.2.6 Universal precautions attire
- 3.2.7 Stethoscope
- 3.2.8 Pulse oximeter: Continuous monitoring of the SpO_2 is essential during continuous nebulizer therapy.

3.3 DPI, MSP, HBA, or USN: See Procedure Sections 4.4 - 4.6

4.0 PROCEDURE

4.1 MDI

- 4.1.1 Verify physician order for therapy.
- 4.1.2 Collect the appropriate equipment.
- 4.1.3 Wash hands.
- 4.1.4 Don universal precautions attire.
- 4.1.5 Introduce yourself to the patient and thoroughly explain the procedure. Proper explanation of the procedure helps to ensure the patient's cooperation. Effective MDI therapy depends upon the patient's effort to coordinate actuation and inspiration appropriately and the ability to hold the inspiration for a minimum of five seconds. An ineffective treatment may result from shallow breathing which reduces the volume of aerosol and decreases the amount of medication deposited in the airways.
- 4.1.6 Assess breathing, auscultate, and check vital signs before, during and after the treatment for patients receiving bronchodilator drugs. Many bronchodilators accelerate inotropy and chronotropy. They may produce precordial distress, palpitation, dizziness, nausea and excessive perspiration.

- 4.1.7 Place the patient in a comfortable sitting or semi-Fowler's position. Diaphragmatic excursion is greater in this position.
- 4.1.8 Shake the MDI canister well immediately before each actuation. Remove the cap from the mouthpiece. Make sure the canister is fully and firmly inserted in the actuator.
- 4.1.9 Instruct the patient to breathe out fully through his/her mouth, expelling as much air from the lungs as possible.
- 4.1.10 Instruct the patient to place the mouthpiece fully into the mouth, holding the MDI in an upright position, while closing his/her lips around the mouthpiece.
- 4.1.11 Instruct the patient to fully depress the top of the metal canister while breathing in deeply and slowly through the mouth.
- 4.1.12 Instruct the patient to hold his/her breath as long as possible. Before breathing out, remove the MDI from the mouth. Observe the patient's chest expansion and ability to coordinate actuation, inspiration and inspiratory hold. Utilize spacer device when necessary.
- 4.1.13 Wait one minute. Shake the MDI canister again. Repeat 4.1.8 - 4.1.13 for each actuation.
- 4.1.14 Encourage the patient to cough after several deep breaths. Have tissues and/or container in close proximity of the patient for expectoration. Suction as needed.
- 4.1.15 Assess the patient for response to therapy including:
 - 4.1.15.1 Proper technique for applying device
 - 4.1.15.2 Patient response to or compliance with procedure
 - 4.1.15.3 Objectively measured improvement (i.e., increased peak flow)
 - 4.1.15.4 Decreased work of breathing, as evidenced by decreased use of accessory muscles
 - 4.1.15.5 Reduction or elimination of symptoms (i.e., stridor, wheezing, congestion)
- 4.1.16 Return patient to pre-treatment position.

NOTE: An MDI can be used in conjunction with mechanical ventilation via the use of an Aerovent spacer device. After pre-treatment assessment and thorough explanation to the patient, the respiratory care practitioner should shake the MDI

canister, actuate the MDI prior to inspiration by the mechanical ventilator. The use of the inspiratory pause/hold will aid in deposition of the medication if tolerated by the patient. The respiratory care practitioner should assess a patient airway, via auscultation, before and after administering MDI therapy. For further instructions, refer to the procedure **"MDI Medication Administration to Mechanically Ventilated Patients."**

4.2 SVN/LVN

- 4.2.1 Verify physician order for therapy.
- 4.2.2 Collect the appropriate equipment.
- 4.2.3 Wash hands.
- 4.2.4 Don universal precautions attire.
- 4.2.5 Introduce oneself to the patient and thoroughly explain the procedure to the patient. Proper explanation of the procedure helps to ensure the patient's cooperation. Effective therapy depends on patient effort to breathe appropriately. Ineffective treatments may result from shallow breathing which reduces the volume of aerosol and increased respiratory rates which decrease the time available for particles to deposit.
- 4.2.6 Assess breathing, auscultate, and check vital signs before, during and after the treatment for patients receiving bronchodilator drugs. Many bronchodilators accelerate cardiac function and may produce precordial distress, palpitations, dizziness, nausea, and excessive perspiration.
- 4.2.7 Place the patient in a comfortable sitting or semi-Fowler's position. The diaphragmatic excursion is greater in this position.
- 4.2.8 Connect the SVN or LVN and connecting tubing to the flowmeter and set the flow at six to eight liters per minute. See the Heart Nebulizers "Guidelines for Preparing Hourly Doses" at the end of this document for specific dosing information and corresponding flowrates.
- 4.2.9 Instruct the patient to exhale, then tell him/her to take in a slow deep breath through the mouthpiece and hold their breath for a few seconds. This will ensure that medication is deposited below the level of the oropharynx.

- 4.2.10 Nose clips may be utilized if the patient has difficulty breathing only through his/her mouth.
- 4.2.11 Instruct the patient to breathe slowly and deeply until all the medication is nebulized.
- 4.2.12 Observe the patient's chest expansion to ascertain that he/she is taking deep breaths. The deep lung inflation may loosen secretions and facilitate expectoration.
- 4.2.13 Encourage the patient to cough after several deep breaths. Have tissues and/or specimen containers in close proximity to the patient for expectoration.
- 4.2.14 After medication is finished, be sure the patient has sufficiently cleared the upper airway by auscultation. Be assured that suctioning is not indicated.
- 4.2.15 Reassess patient for response to therapy including:
 - NOTE:** For continuous nebulizer therapy, the patient should be assessed at least once every two hours.
 - 4.2.15.1 Proper technique for applying device
 - 4.2.15.2 Subjective response to or compliance with procedure
 - 4.2.15.3 Objectively measured improvement (i.e., increased peak flow)
 - 4.2.15.4 Decreased work of breathing, as evidenced by decreased use of accessory muscles
 - 4.2.15.5 Reduction or elimination of symptoms (i.e., stridor, wheezing, congestion)
 - 4.2.15.6 Improvement in SpO₂ or arterial blood gases
 - 4.2.15.7 Evidence of not tolerating therapy: skeletal muscle tremor, increased blood pressure, tachycardia, dysrhythmia, or metabolic disturbances
- 4.2.16 Return the patient to pre-treatment position.

4.3 Elective Conversion of SVN to MDI

- 4.3.1 After thorough assessment of patient's ability to perform an MDI treatment, the respiratory care practitioner may elect to convert any SVN treatment to MDI.
- 4.3.2 Patients who prefer SVN for delivery of aerosolized medication will not be electively converted to MDI.
- 4.3.3 Medication dose conversion from SVN to MDI:

4.3.3.1	<u>SVN</u>	<u>MDI</u>
Albuterol	0.5 ml	4 puffs
Albuterol	0.25 ml	2 puffs
Alupent	0.3 ml	3 puffs
Atrovent	2.5 ml	4 puffs
Combivent		4 puffs

4.4 MSP or DPI: Consult the package insert for proper administration instructions.

4.5 HBA: Power the atomizer via the compression bulb or, alternatively, use a gas source to aerosolize the topical agents. Patients should be able to cooperate with administration for optimal therapy. A tongue depressor may be used to aid in drug delivery.

4.6 USN: Fill the couplant chamber with distilled water. Place the medication to be nebulized in a disposable solution cup, and position the solution cup within the couplant chamber. The water volume in the couplant chamber should produce sound waves adequate to create a dense aerosol output. Administer the aerosol to the patient via corrugated tubing and mask. The patient should be instructed to take slow, deep breaths throughout the treatment.

5.0 POST PROCEDURE

5.1 MDI/MSP/DPI and Accessory Devices

5.1.1 Remove the MDI/MSP/DPI canister and cleanse the plastic housing and cap by rinsing thoroughly in sterile water at least once a day. After thoroughly drying the plastic housing and cap, replace the canister into the plastic housing with a twisting motion and replace the cap. These products are for single patient use only. Dispose of properly.

5.1.2 If administering a treatment through a mechanical ventilator, return the spacer to the "closed" position. Replace the spacer once per week and PRN according to the ventilator circuit change schedule. **NOTE:** Consult the package insert before attempting to deliver DPI medications through the ventilator. Dry powder aerosols are usually not stable in humidified gas.

5.2 SVN/LVN: Disassemble and clean the SVN/LVN after each use with sterile water. After thorough drying, place the device in a clean plastic bag at the patient's bedside. This equipment should be changed every 48 hours.

- 5.3 HBA: Disassemble and rinse the parts of the device in tap water. Soak the capillary tube in hydrogen peroxide for 20 minutes. Deliver the other parts to Central Hospital Supply for ethylene oxide gas sterilization.
- 5.4 USN: Dispose of the solution cup, tubing, and mask. Dump the water out of the couplant chamber, and wipe the chamber dry. Disinfect the USN unit with alcohol or Dispatch, setup device and store in appropriate ready room areas.
- 5.5 Suggest recommendations for modifications to therapy as evidenced by quantitative pulmonary function data, respiratory assessment, and patient response.

6.0 DOCUMENTATION

6.1 Document all treatment information. In the 10D MICU, medicinal aerosol delivery should be documented on the “Continuous Ventilation Record” in the “Comments” section. Additionally, in 10D and 2J, staff must place their initials in the appropriate areas of the “Medication” section, on the nursing flow sheet. All documentation, other than in the 10D MICU, should be entered into the MIS via the “aerosol therapy” reporting pathway. The following is required documentation:

- 6.1.1 Mode of therapy (HHN, USN, MDI’s, etc....)
- 6.1.2 Medication dosage administered
 - 6.1.2.1 Actual time given documented under “chart meds.”
 - 6.1.2.2 Medication and Dosage must also be typed into the aerosol therapy note.
- 6.1.3 Patient tolerance of procedure
- 6.1.4 Response to therapy
- 6.1.5 Pre and post respiratory rates
- 6.1.6 Pre and post breath sounds
- 6.1.7 Pre and post heart rates
- 6.1.8 Cough effort/suction requirement
- 6.1.9 Secretion description

- 6.1.10 **For continuous nebulizer therapy:** Document the dosage of medication delivered in mg/ml and the amount of normal saline diluent in ml to achieve a patient dose expressed in mg/hr. Refer to the Heart Nebulizers "Guidelines for Preparing Hourly Doses" below.
- 6.1.11 All "while awake" and "prn" treatments must be assessed around the clock and documented either in the MIS or on the "Continuous Ventilation Record" (10D MICU only).
- 6.1.12 All delayed or missed treatments should be documented either in the MIS or on the "Continuous Ventilation Record." Documentation should include why treatment was delayed or not given. If the treatment is not given, the medication must be charted as "not given" in the MIS via the "chart meds pathway."

7.0 REFERENCES

- 7.1 AARC Clinical Practice Guideline "Selection of Aerosol Delivery Device."
- 7.2 AARC Clinical Practice Guideline "Delivery of Aerosols to the Upper Airway."
- 7.3 AARC Clinical Practice Guideline "Selection of an Aerosol Delivery Device for Neonatal and Pediatric Patients."
- 7.4 AARC Clinical Practice Guideline "Assessing Response to Bronchodilator Therapy at Point of Care."
- 7.5 Nursing 91 Drug Handbook.
- 7.6 Eubanks and Bone, eds. Comprehensive Respiratory Care. St Louis: The C.V. Mosby Company, 1985.
- 7.7 Buck ML. Administration of albuterol by continuous nebulization. AACN Clinical Issues 1995; 6(2):279-286.
- 7.8 DeNicola LK, Monem GF, Gayle MO, Kissoon N. Treatment of critical status asthmaticus in children. Pediatric Clinics of North America 1994;41(6):1293-1324.

SIGNATURE: _____
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Medical Director, CCTRCS, CCMD

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